Infrared Microspectroscopy to Assess Neurodegeneration

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Infrared microspectroscopy has the potential to provide chemical images of protein, nucleic, acid and lipid distributions of living cells as well as images of stained tissue and unstained tissue sections permitting tissue and single cell mapping of diseased and healthy tissues. Hippocampal tissue from humans with chronic temporal lobe epilepsy (TLE) reveals a specific pattern of neuronal degeneration referred to as mesial temporal sclerosis. The predominant features of mesial temporal sclerosis include selective loss of pyramidal neurons in the hippocampal endblades (CA3 area) and frequently, the Sommer sector (CA1 area). Kainic acid seizures in animals are frequently used as a model for human TLE. Both kainic acid seizures and TLE result in partial seizures with secondary generalization and a similar pattern of hippocampal damage characterized by the loss of CA3 pyramidal cells. We utilized the model of kainic acid status epileptic us to examine healthy and diseased neural tissue using the new method of synchrotron infrared microspectroscopy in an interdisciplinary collaboration of neuroscientists and biophysicists. The protein, lipid, disulfide, ketone, and phosphate (nucleic acids) regions of the mid-infrared spectrum were examined to determine biochemical differences in healthy and diseased issue. Cellular images were also examined at the diffraction limit (apertures of 3-5 μm).

Superimposing the visible and infrared images of hippocampal areas, a significant change was observed in the diseased neural tissue with respect to that of control. Ratioing amide I to lipid bands, it was found that diseased neural cells loose their integrity, spreading their bio-material towards the surrounding tissue. Further work involves examining the far-IR spectral region below 600 cm-1 to include phosphate and nucleic acid signatures where damage by apoptosis is known to occur.